

1                   METHODS AND APPARATUS FOR SUSPENDING FIXTURES

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3                   BACKGROUND OF THE INVENTION

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5           1. Field of the Invention

6                 The invention relates to mechanical fasteners. More  
7                 particularly, the invention relates to mechanical fasteners  
8                 suitable for suspending fixtures such as acoustic tile ceilings,  
9                 pipes, lighting fixtures, electrical cables, HVAC equipment etc.

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12           2. State of the Art

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Current practice in the construction trade and building industry is to suspend fixtures with wires which are fastened to a wall or ceiling. An example of a state of the art apparatus for suspending fixtures is illustrated in prior art Figure 1. The apparatus generally includes an angle bracket 10 having two holes 12, 14, a fastener 16 (typically a nail or a screw), and a length of wire 18 (often six to eight feet long). The method for using the apparatus includes attaching the wire 18 through one of the holes 14, inserting the fastener 16 through the other hole 12, and fastening the fastener 16 to a wall or ceiling 20. An exemplary bracket and fastener are illustrated in U.S. Patents Number 5,178,503 and Number 4,736,923.

1       The apparatus shown in Figure 1 is often used to suspend  
2 fixtures from cement, stone, or other masonry material ceilings,  
3 typically in commercial buildings. The wires 18 are attached to  
4 ceiling tile grids, pipe brackets, HVAC ducts, lighting fixtures,  
5 etc. Because a relatively large variety of equipment is hidden  
6 above a suspended acoustic tile ceiling in a commercial building,  
7 the wires 18 are often six to eight feet long.

8

9       The fastener 16 is usually pre-fit into the hole 12 of the  
10 bracket 10 during manufacture. However, the wire 18 (usually 12  
11 gauge galvanized steel) must be manually attached to the bracket  
12 10 by inserting a free end of the wire through the hole 14,  
13 looping the wire onto itself and twisting it as shown in Figure 1.  
14 This is often done by hand with a pair of pliers or may be done  
15 with the aid of a hand operated (or drill operated) crank such as  
16 the "wire tying fixture", item number 00052075, sold by Hilti,  
17 Inc., Tulsa, Oklahoma. These methods of attaching the wire to the  
18 bracket present several disadvantages.

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20       The most apparent disadvantage is the cost of labor for the  
21 labor intensive task of twisting the wire. In order to be  
22 reasonably secure and satisfy some municipal codes, approximately  
23 eight inches of the wire must be twisted eight to ten turns about  
24 itself. In practice, many workers only twist the wire three or  
25 four times about itself. Still, the work is time consuming. The

1 best productivity is not much more than about 300 pieces per hour  
2 and after about 500 pieces the worker needs to rest.

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4 Another disadvantage is that this method of connecting the  
5 wire to the bracket is not very secure. Under a stress of about  
6 50 lbs., the wire loop stretches and under a stress of about 210  
7 lbs. the wire untwists.

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9 Still another disadvantage is that the connection between the  
10 wire and the bracket is loose. Under normal circumstances,  
11 gravity provides tension between the wire and the bracket.  
12 However, in the case of an earthquake or a fire, the loose  
13 connection between the wire and the bracket allows vibration and  
14 movement of the fixtures supported by the wire. This can result  
15 in fixtures falling onto emergency workers and other similar  
16 hazards.

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18 SUMMARY OF THE INVENTION

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20 It is therefore an object of the invention to provide  
21 improved methods and apparatus for suspending fixtures.

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23 It is also an object of the invention to provide methods and  
24 apparatus for suspending fixtures which are not labor intensive.

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1        It is another object of the invention to provide methods and  
2        apparatus for suspending fixtures which are more economical than  
3        the state of the art.

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5        It is still another object of the invention to provide  
6        methods and apparatus for suspending fixtures which are safer and  
7        stronger than the state of the art.

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9        In accord with these objects which will be discussed in  
10       detail below, the apparatus of the present invention includes an  
11       angle bracket with a hole for a fastener and a flange for coupling  
12       a wire to the angle bracket. The flange is lanced and it is  
13       coupled to the wire by crimping. According to a first embodiment  
14       of the invention, the flange is provided with two horizontal  
15       lances. According to a second embodiment, the flange is provided  
16       with at least three alternating horizontal lances. According to a  
17       third embodiment, the flange is provided with a horizontal lance  
18       and a vertical lance. According to a fourth embodiment, the  
19       flange is provided with a vertical lance in the shape of a hook  
20       and an eyelet is provided for connecting the wire. According to a  
21       fifth embodiment, the flange is wrapped to form a slotted  
22       cylinder. The wire is inserted into the slotted cylinder which is  
23       then compressed and crimped onto the wire. According to a sixth  
24       embodiment, the angle bracket is provided with two wire connecting

1 flanges. A seventh embodiment is similar to the sixth embodiment  
2 with features of the second embodiment.

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4 A kit according to the invention includes a plurality of  
5 lanced angle brackets, a plurality of pre-cut lengths of wire, and  
6 a combined crimping and testing tool.

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8 The apparatus of the invention is stronger than the state of  
9 the art apparatus. Wire crimped to the bracket does not begin to  
10 stretch until a stress of approximately 420 lbs. is applied. This  
11 is about twice as strong as the looped wire and bracket  
12 combination of the prior art. According to the preferred  
13 embodiments, only about 3/4" of wire is crimped to the bracket.  
14 Thus, almost eight inches of wire is saved in each assembly.  
15 Using the crimping tool of the invention, a worker can produce  
16 2,000 wire-bracket assemblies per hour, nearly seven times the  
17 productivity of the prior art method. In addition, the methods  
18 and apparatus of the invention produce consistent results and do  
19 not rely on the integrity of the assembly worker to perform the  
20 required number of twists. Furthermore, the connection between  
21 the bracket and the wire according to the invention is a rigid  
22 connection which enhances the safety of the apparatus.

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24 Additional objects and advantages of the invention will  
25 become apparent to those skilled in the art upon reference to the

1 detailed description taken in conjunction with the provided  
2 figures.

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4 BRIEF DESCRIPTION OF THE DRAWINGS

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6 Figure 1 is a schematic side elevational view, in partial  
7 section, of a state of the art apparatus for suspending fixtures;

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9 Figure 2 is a side sectional view of a first embodiment of a  
10 bracket according to the invention;

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12 Figure 3 is a side elevational view of the bracket of Figure  
13 2;

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15 Figure 4 is a bottom plan view of the bracket of Figures 2  
16 and 3;

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18 Figure 5 is a side sectional view of the bracket of Figures  
19 2-4 with a wire attached to it;

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21 Figure 6 is a view similar to Figure 5 of a second embodiment  
22 of a bracket according to the invention with a wire inserted but  
23 prior to crimping;

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1       Figure 7 is a side sectional view of a third embodiment of a  
2 bracket according to the invention with a wire inserted but prior  
3 to crimping;

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5       Figure 8 is a side sectional view of a fourth embodiment of a  
6 bracket according to the invention;

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8       Figure 9 is a side elevational view of a wire with an eyelet  
9 for use with the fourth embodiment of the bracket of the  
10 invention;

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12      Figure 10 is a side elevational view in partial section of a  
13 fifth embodiment of a bracket according to the invention;

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15      Figure 11 is a bottom view of the fifth embodiment;

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17      Figure 12 is a side elevational view in partial section of a  
18 sixth embodiment of a bracket according to the invention;

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20      Figure 13 is a view similar to Figure 12 of a seventh  
21 embodiment of the invention;

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23      Figure 14 is a top view of the seventh embodiment;

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25      Figure 15 is a view in the direction 15-15 of Figure 14; and

1       Figure 16 is a schematic side elevational view of a crimping  
2 and testing apparatus according to the invention.

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4                   DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

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6       Referring now to Figures 2-4, a first embodiment of the  
7 invention includes an angle bracket 100 having a first flange 102  
8 and a second flange 104. The first flange 102 is provided with a  
9 hole 106 for receiving a fastener such as a nail (not shown). The  
10 second flange 104 is lanced in two places to provide loops 108,  
110 which are dimensioned to receive an appropriate wire.

12

13       It is intended that the words lance, lanced, and lances be  
14 read broadly enough to include any procedure which results in the  
15 described structure. Thus, it may be possible, for example, to  
16 cast the angle bracket in a single operation which results in the  
17 described structure.

18

19       Figure 5 illustrates the first embodiment 100 with a wire 112  
20 inserted into the loops 108, 110 and the loops crimped tight  
21 against the wire.

22

23       It will be appreciated that the method of using the apparatus  
24 of the invention includes inserting the end of the wire through  
25 the loops, crimping the loops, inserting a fastener through the

1 hole, fastening the bracket to a surface with the fastener,  
2 attaching the other end of the wire to a fixture.

3

4 Figure 6 illustrates a second embodiment of the invention.  
5 The second embodiment includes an angle bracket 200 having a first  
6 flange 202 and a second flange 204. The first flange 202 is  
7 provided with a hole 206 for receiving a fastener such as a nail  
8 207. The second flange 204 is lanced in at least three places to  
9 provide loops 208, 209, 210, 211, and 213. The loops are  
10 alternated in opposite directions. Figure 6 shows a wire 212  
11 inserted through the loops. It will be appreciated that in this  
12 embodiment, because of the alternating loops, the flange 204 stops  
13 the wire 212 from passing beyond the upper loop 208.

14

15 Turning now to Figure 7, a third embodiment of the invention  
16 includes an angle bracket 300 having a first flange 302 and a  
17 second flange 304. The first flange 302 is provided with a hole  
18 306 for receiving a fastener (not shown). The second flange 304  
19 is lanced in two places to form a tongue 308 and a loop 310. The  
20 tongue 308 is provided with a hole 309 which is dimensioned to  
21 receive a wire 312. According to this embodiment, the end of the  
22 wire 312 is bent approximately 180° and inserted into the hole 309  
23 and the loop 310. The tongue 308 and the loop 310 are then  
24 crimped against the wire 312. It will be appreciated that the

1 tongue 308 and the loop 310 can be crimped against the wire before  
2 the wire 312 is bent.

3

4 Figures 8 and 9 illustrate a fourth embodiment of the  
5 invention. The fourth embodiment includes an angle bracket 400  
6 having a first flange 402 and a second flange 404. The first  
7 flange 402 is provided with a hole 406 for receiving a fastener  
8 (not shown). The second flange 404 is lanced to form a hook  
9 structure 408. As shown in Figure 9, a wire is coupled to an  
10 eyelet 414 by crimping. According to this embodiment of the  
11 invention, the eyelet 414 is coupled to the hook 408 and the hook  
12 408 is preferably crimped over the eyelet 414. Those skilled in  
13 the art will appreciate that this embodiment could be used with  
14 the looped prior art wire 18 shown in Figure 1. Such a  
15 combination would obtain some of the advantages (strength and  
16 physical integrity) of the invention but not the other advantages  
17 (e.g. ease of use, economy of labor, etc.).

18

19 Figures 10 and 11 illustrate a fifth embodiment of the  
20 invention. The fifth embodiment includes an angle bracket 500  
21 having a first flange 502 and a second flange 504. The first  
22 flange 502 is provided with a hole 506 for receiving a fastener  
23 such as a masonry nail 507. As illustrated in Figure 10,  
24 structure is provided to secure the nail to the hole so that the

1 bracket 500 can be easily located by an installer using one hand  
2 and the nail driven with a tool using the other hand.

3

4 The second flange 504 is rolled from two sides 508, 510 to  
5 form a slotted cylinder for receiving a wire 512. After a wire  
6 512 is inserted into the cylinder, it is compressed and crimped,  
7 e.g. as shown at 513 and 515.

8

9 It will be appreciated that the fifth embodiment shows an  
10 angle bracket having an approximately 45° angle whereas the  
11 previous embodiments illustrated an approximately 90° angle. Those  
12 skilled in the art will appreciate that in some applications a 45°  
13 angle is preferred over a 90° angle. For example, if a fixture is  
14 mounted at opposite sides with 45° angle brackets, the resulting  
15 structure will be resistant to lateral movement which might  
16 otherwise be caused during an earthquake, for example.

17

18 Figure 12 illustrates a sixth embodiment of the invention  
19 which is similar to the fifth embodiment. Similar features of  
20 this embodiment are referenced with similar (increased by 100)  
21 reference numerals. According to the sixth embodiment a third  
22 flange 604b is provided on an opposite side of the first flange  
23 602 directly opposed from the second flange 604a. This permits  
24 two wires 612a, 612b to be coupled to the angle bracket 600.

25

1       According to the invention, it is also possible to provide  
2       the angle bracket with additional flanges for coupling three or  
3       four or even more wires depending on the configuration of the  
4       first flange. For example, the first flange could be shaped as  
5       any polygon, thereby determining the maximum number of wire  
6       coupling flanges.

7

8       Those skilled in the art will appreciate that the masonry  
9       nails 607 of the type used in prior art apparatus for suspending  
10      fixtures can support more than one thousand pounds. Thus, when  
11      suspending a plurality of relatively lightweight fixtures,  
12      significant labor reduction can be achieved by using appropriately  
13      positioned angle brackets with multiple wires coupled to each  
14      bracket.

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16       Figures 13-15 illustrate a seventh embodiment of the  
17      invention which combines features of the sixth and second  
18      embodiment. The reference numerals in Figures 13-15 are similar  
19      (in their last two digits) to the reference numerals used in  
20      Figures 6 and 12 and correspond to similar features as those  
21      referenced in Figures 6 and 12.

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23       A kit according to the invention includes a plurality of  
24      lanced angle brackets, a plurality of pre-cut lengths of wire, and

1 a combined crimping and testing tool. Figure 13 illustrates a  
2 crimping and testing tool 700.

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4         Turning now to Figure 13, the tool 800 includes a lever 802  
5 coupled by a pivot 804 on a pivot arm 805 which is coupled to a  
6 base 815. A spring 806 on one side of the pivot arm 805 holds the  
7 lever 802 in a raised position. The lever 802 is provided with a  
8 crimping hammer 808 and a crimping anvil 810 is located below the  
9 hammer 808. It will be appreciated that by placing the second  
10 flange of one of the angle brackets of the invention onto the  
11 anvil 810, and pressing down on the lever 802, the hammer 808 will  
12 form the crimps described above.

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14         The tool 800 also preferably includes a tension spring 812  
15 coupled to the base 815, a first mounting 814 coupled to the  
16 spring 812, and a second mounting 816 coupled to the lever 802.  
17 The mountings are adapted to couple with an angle bracket and a  
18 wire attached to the angle bracket. when an angle bracket and  
19 wire are coupled to the mountings and the lever is pressed down,  
20 the integrity of the coupling between the bracket and the wire  
21 will be stressed. The spring 812 preferably has a spring constant  
22 which will stress the bracket-wire coupling sufficiently to insure  
23 that the coupling will support the desired load.

24

1        According to the presently preferred embodiment, the lever  
2    802 has two telescoping parts 807, 809 so that its length can be  
3    adjusted. A pin 803 and a plurality of holes 813a-913c lock the  
4    telescoping parts in a selected length. A soft hand grip is  
5    preferably provided at the end of the lever 802. The base 815 is  
6    preferably provided with wire guides 811, 813 to stabilize the  
7    wire during crimping. According to the presently preferred  
8    embodiment, the spring 812 is selected to provide a stress of  
9    approximately two hundred pounds to the crimp when the lever is  
10   pressed down.

11  
12       The apparatus of the invention is stronger than the state of  
13    the art apparatus. Wire crimped to the bracket does not begin to  
14    stretch until a stress of approximately 420 lbs. is applied. This  
15    is about twice as strong as the looped wire and bracket  
16    combination of the prior art. According to the preferred  
17    embodiments, only about 3/4" of wire is crimped to the bracket.  
18   Thus, almost eight inches of wire is saved in each assembly.  
19   Using the crimping tool of the invention, a worker can produce  
20   2,000 wire-bracket assemblies per hour, nearly seven times the  
21   productivity of the prior art method. In addition, the methods  
22   and apparatus of the invention produce consistent results and do  
23   not rely on the integrity of the assembly worker to perform the  
24   required number of twists. Furthermore, the connection between

1 the bracket and the wire according to the invention is a rigid  
2 connection which enhances the safety of the apparatus.

3

4 There have been described and illustrated herein several  
5 embodiments of methods and apparatus for suspending fixtures.  
6 While particular embodiments of the invention have been described,  
7 it is not intended that the invention be limited thereto, as it is  
8 intended that the invention be as broad in scope as the art will  
9 allow and that the specification be read likewise. It will  
10 therefore be appreciated by those skilled in the art that yet  
11 other modifications could be made to the provided invention  
12 without deviating from its spirit and scope as so claimed.

13